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Colossal Magnetoresistant Materials: The Key Role of Phase Separation

Adriana Moreo, Jan Burgy, and Elbio Dagotto
National High Magnetic Field Lab, Florida State University, Tallahassee, FL 32306

Recent computational and mean-field studies of manganites, materials that exhibit the "Colossal" Magnetoresistance (CMR) effect, revealed intrinsically inhomogeneous ground-states in realistic models due to the presence of tendencies toward phase separation [1]. The effect typically involves ferromagnetic metallic and antiferromagnetic charge and orbital ordered insulating states. The mixed-phase tendencies have two origins: (i) electronic phase separation between phases with different densities that lead to nanometer scale coexisting clusters, and (ii) disorder-induced phase separation with percolative characteristics between equal-density phases, driven by disorder near first-order metal-insulator transitions. It is argued that a large variety of experiments reviewed here contain results compatible with the theoretical predictions. Recent developments include the generation of features resembling quantum critical points both in theory and experiments, calculations of resistivities using random resistor networks revealing a strong MR effect, as well as the presence of stripes and pseudogap features at high temperatures [2]. Lessons learned in the context of manganites, can also be applied to cuprates, as discussed here.

[1] A. Moreo *et al.*, Science **283**, 2034 (1999); PRL **84**, 5568 (2000); E. Dagotto *et al.*, to appear in Physics Reports, cond-mat/0012117.

[2] M. Mayr *et al.*, PRL **86**, 135 (2001); T. Hotta *et al.* cond-mat/0012098; J. Burgy *et al.*, preprint 2001.